The Next Generation Nuclear Plant Project

The Case for Utility Interest

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Technical Update, December, 2008

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PRODUCT DESCRIPTION

This Technology Update documents the Next Generation Nuclear Plant (NGNP) project, which will demonstrate the design, licensing, construction, and operation of a new nuclear energy source using high-temperature gas-cooled reactor (HTGR) technology. This new non-emitting energy source is applicable to a broad range of uses, from generating electricity to providing high-temperature industrial process heat to producing hydrogen. The NGNP project is sponsored as part of the Energy Policy Act of 2005 and envisions support by a public/private partnership. The demonstration plant is scheduled for commissioning in 2021 and will produce electricity and process heat and hydrogen.

Results and Findings

The pre-conceptual design of NGNP is nearly complete, and the licensing strategy is developed and accepted by the Nuclear Regulatory Commission (NRC). Based on the request for information (RFI) issued earlier this year, the Department of Energy (DOE) is expected to issue a funding opportunity announcement by the end of CY2008 for selection of the supplier(s) to complete conceptual design and proceed with the initial steps of licensing.

Preliminary economic assessments based on available data indicate that NGNP and subsequent HTGRs can be competitive with other forms of energy, particularly natural gas, without the need to include the cost of carbon constraints.

This type of nuclear energy supply provides three benefits to EPRI members. First, HTGRs provide options to utilities for smaller nuclear power plants that should be competitive with natural-gas-fired plants. Second, HTGRs deployed for process heat plants will require experienced companies to operate the reactor systems, which provides nuclear utilities additional business opportunities. Finally, there are major opportunities for utilities to supply different forms of nuclear-produced energy as owner/operators. There are large potential markets for HTGR co-generating electricity and process heat and hydrogen for industrial applications. Industrial processes include oil refining and chemical, ammonia, and fertilizer production. Production of synthetic fuels and refinery feedstock from unconventional hydrocarbons, such as tar sands, coal, heavy oil, biomass and oil shale, all present additional major opportunities

Challenges and Objective(s)

Any new energy source faces challenges in development and deployment. HTGR's greatest challenges are to secure a combined construction and operating license and design certification from NRC. NGNP will pave the way for future HTGR commercial deployment with its broad range of applications to improve energy security and environmental stewardship.

Applications, Values, and Use

The potential market for HTGRs is quite large. Estimates provided to the Department of Energy (DOE) in September 2008 for such nuclear energy plants providing industrial process heat to refineries and chemical, petrochemical, and ammonia plants exceed 300 units at 500 MW(t). Similarly, future coal-to-liquids plants may require several hundreds of HTGRs, depending on deployment of such conversion plants. Finally, over two hundred HTGRs may be deployed to provide the required steam and electricity for producing tar sands in Canada. These figures do not include those HTGRs that may be configured to produce emission-free electricity.

Deployment in all cases depends heavily on the price and availability of natural gas and cost of carbon constraints.

EPRI Perspective

This evolving technology should be considered by utilities as a potential option for providing emission-free electricity that does not have intermittency issues associated with other non-emitting generation technologies, such as wind and solar. HTGRs do not have fuel transport issues associated with biomass generating stations. Finally, HTGR nuclear-generating stations are modular and available in sizes of about 200 MW(e) [500MW(t)]. Therefore, they offer a lower financial exposure than the larger light water reactor plants of 1200 MW(e) and above. As discussed, HTGRs present additional opportunities for utilities to provide operational support and produce additional energy products from nuclear energy.

Approach

The goals of this Technology Update are to 1) provide a description and status report on the NGNP project, 2) provide sound business reasons for utilities to be interested in deployment opportunities provided by NGNP, and 3) identify challenges to the completion of the NGNP project. This update provides a statement and summary supporting evidence for each of these goals.

Keywords

Nuclear energy
High-temperature gas-cooled reactors
Emission-free
Electricity generation
Modular
Hydrogen generation
Process heat
Industrial applications
Oil refining
Chemical manufacturing

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CONTENTS

1 OVERVIEW

Objective of the Next Generation Nuclear Plant (NGNP) Project

According to the Department of Energy (DOE), the strategic goal of the Next Generation Nuclear Plant (NGNP) Project is to broaden the environmental and economic benefits of nuclear energy technology by demonstrating its applicability to industry sectors not currently served by commercial light water reactors. The DOE will pursue the following objectives in the execution of the NGNP Project:

- Develop the HTGR technology, design and licensing strategy through a public/private partnership resulting from a competitive selection process,
- Demonstrate the basis for commercialization through construction and reliable operations of an HTGR prototype facility and associated technologies, and
- Demonstrate readiness and capacity of U.S. nuclear manufacturing, design, and construction infrastructure for HTGR.

The NGNP commercial demonstration project has an expected total cost of approximately $4.3 billion (2007$). The Energy Policy Act passed by the U.S. Congress in 2005 (EPAct 2005) calls for the federal government through the U.S. Department of Energy (DOE) to provide up to $1.25 billion through 20151 to support the NGNP demonstration on the condition that the private sector shares a significant portion of the costs. The HTGR technology developers have indicated that they can bring significant value-added design and engineering, fuel experience, fabrication technology and power conversion technology to the private side of the partnership(s). It is expected that the remainder of the private share will be raised by securing funding from leading end-users of the commercial HTGR systems and other interested parties.

The basis for the HTGR technology embodied in the NGNP was first developed over 40 years ago in the U.K., the U.S. and Germany. Most of the work to date has focused on the generation of electricity. A commercial scale demonstration of a specific HTGR concept for electric power generation using the direct Brayton cycle concept is being designed and built in South Africa. Other HTGR system-related development efforts exist in France, Japan, Russia, China and South Korea at the design stage or engineering pilot scale.

In summary, the NGNP Project is designed to demonstrate the capabilities, licensability and commercial viability of the HTGR technology to meet the future market needs of a broad range of end-users ranging from electricity generation companies, to oil companies, chemical companies, to hydrogen producers, to other process industries, and even to companies that will produce synfuels from unconventional oil deposits with minimal CO_2 emissions. It is a multi-phased project with a graded funding obligation with limited early amounts to attract the widest range of participation. This breadth of participation should assure that essential, near-term

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[1] The Energy Policy Act of 2005 authorizes $1.25 billion for NGNP Demonstration Plant for the years 2006 through 2015 and such sums as necessary for each of the fiscal years 2016 through 2021..

market needs are addressed in the design, construction and operation of the demonstration facility. The subsequent phases require significant execution oversight and financial participation from private and public sources to drive the design and licensing of the plant, and its construction and operation. The development of an effective public-private partnership is a practical way to achieve these complex and congruent business and government goals.

2
HIGH TEMPERATURE GAS COOLED REACTOR (HTGR) TECHNOLOGY

The HTGR-based NGNP uses nuclear fission to produce heat, similar to the over 440 nuclear reactors in operation globally, but with several important differences. Unlike the bulk of the world's operating light water reactors (LWRs), the HTGR uses helium instead of water to cool the nuclear core and transfer heat for the energy conversion function of the reactor system. This helium "coolant" and the use of graphite as the neutron "moderator" give the HTGR its unique capability to operate at very high temperatures – much higher than all other reactor designs. HTGRs operate at approximately 800º C, with even higher temperatures possible. This is in contrast to 300º C for existing LWRs.

At these higher temperatures, HTGRs can achieve higher efficiency and also perform "process heat" missions beyond the capabilities of existing reactor types. HTGR plants are also smaller in capacity than conventional LWRs, which provide advantages for some electricity generation applications. Plant size has been a factor in the appeal of LWRs for baseload electricity generation, because of their "economy-of-scale" advantage in this marketplace. Newer HTGR designs are capable of supporting certain electricity generation needs. These smaller plants provide modular capacity additions with lower overall financial risk for smaller US utilities. These designs may be deployable in remote locations without established, robust high voltage transmission systems to support large central generating stations.

The NGNP Demonstration concept is shown as Figure 2-1. This figure shows the HTGR nuclear system (heat source) and turbine generator electric power facility, the process heat applications facility and the hydrogen facility. Electricity is generated by taking the process heat from the reactor through a secondary heat exchanger and transport system to drive a power conversion system. The hydrogen facility also receives heat from the reactor through a secondary heat exchanger and transport system to produce hydrogen using either a thermo-chemical or a high temperature electrolysis process. The process heat applications facility investigates and demonstrates a wide range of potential process heat applications.

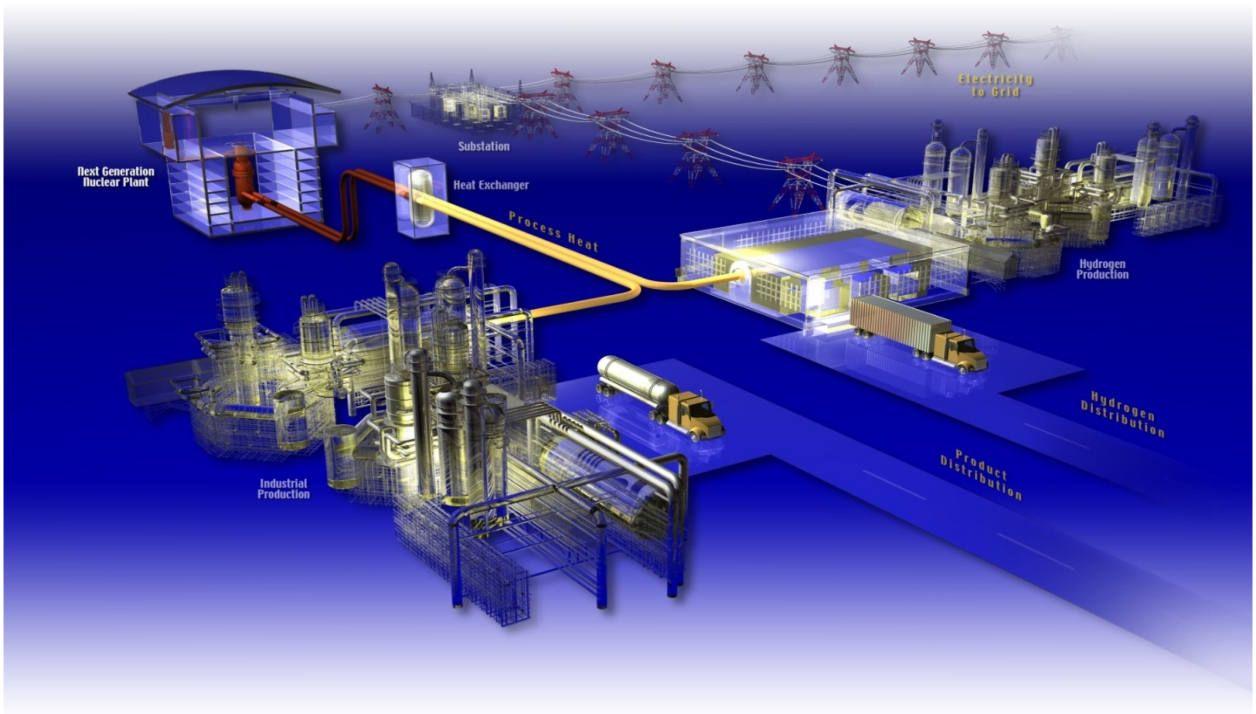

Figure 2-1
Artist Rendering of the NGNP, illustrating the HTGR heat source with the, electricity generation facility, the hydrogen production facility with underground pipeline, and a process heat application facility

HTGR technology is over 40 years old, having been developed in the U.K., in Germany and in the U.S., see Figure 2-2. HTGRs have most often been used to generate electricity. The process heat mission has long been envisioned, but only with modern HTGR technology and growing markets for process heat and hydrogen has this newer mission for the HTGR emerged. The advantages of the HTGR in co-generation, process heat and hydrogen missions are to (1) produce energy without emitting pollutants or greenhouse gases, and (2) maintain superior performance in all areas of safety, reliability, and economy.

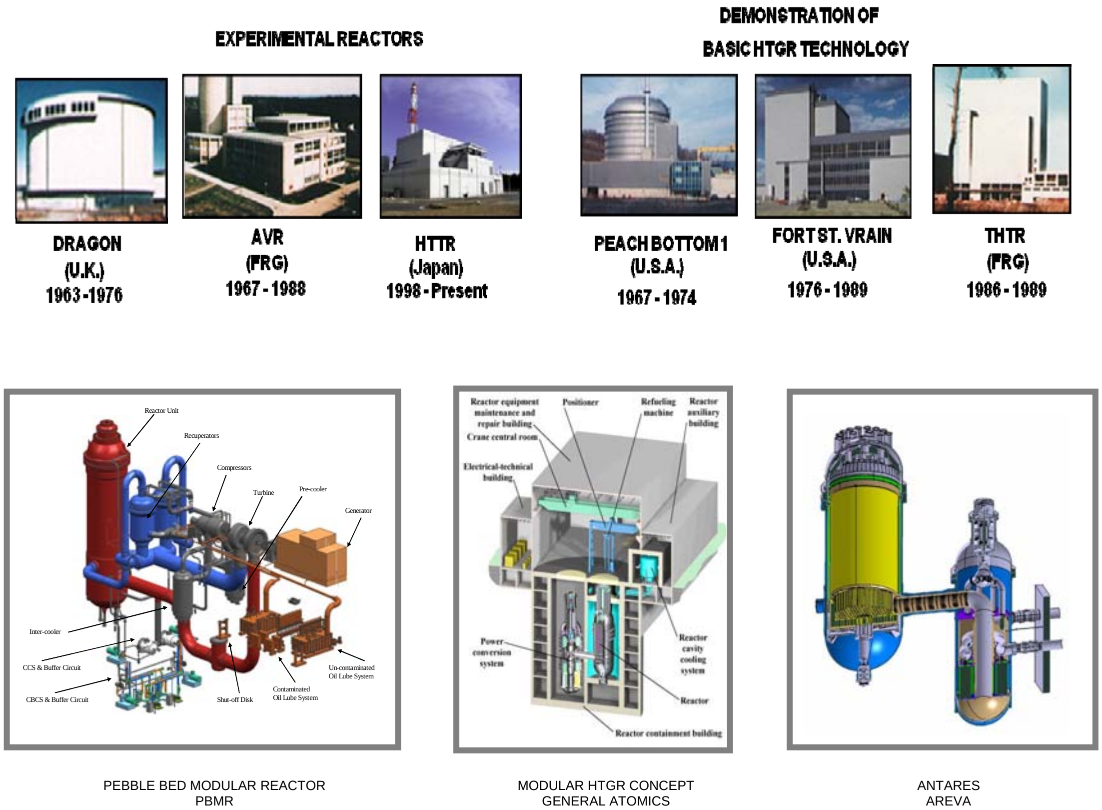

Figure 2-2
Evolution of the HTGR from the Early Reactors in the U.K., Germany and the U.S. to the Current Three HTGR Designs

The U.S. industry and government have long championed the development of HTGR technology. In particular, Congress has supported HTGR development, but HTGR programs have typically been focused on R&D to address technology gaps in the more advanced design concepts. Federal appropriation levels have never reached the point of being able to support an actual demonstration project and lead to commercialization. With the passage of the Energy Policy Act of 2005, Congress has authorized design and construction of a U.S. demonstration HTGR – the NGNP Project.

There are two variants of the HTGR design for heat and power generation. The first variant is the “direct cycle”, which can be used in electricity generation applications. In these cases the hot helium from the core passes directly to a closed loop“gas” turbine to generate electricity. This direct Brayton cycle arrangement provides the most efficient means for generating electricity with overall efficiencies in the mid 40 percent range.

The second variant is the indirect cycle design. With the indirect cycle, the HTGR can provide high temperature process heat in the form of steam or high temperature gas or fluid to perform a variety of industrial functions in the petroleum, fertilizer, and coal industries. The high temperature can also be used to generate hydrogen, which can be used as a fuel or an additive in various industrial processes, such “sweetening” heavy (crude) oil to refine higher octane gasoline. Process heat applications include synthetic gas production and coal liquefaction for the coal industry, cost-effective extraction of oil from unconventional deposits including tar sands, steel production, paper manufacturing, and water desalination. The NGNP design will be an indirect cycle in order to co-generate electricity, process heat and hydrogen.

One of the unique features of the HTGR is its fuel. All HTGRs use a small (~1mm diameter) fuel particle as its basis. These small fuel particles have a kernel of enriched uranium in the form of an oxide (or carbide), coated with a porous carbon layer to absorb fission gases, which is surrounded by a hard pyrolytic carbon layer, covered by a silicon carbide layer and finally covered by another pyrolytic carbon layer, see Figure 2-3. These "TRISO" particles are extremely robust and can withstand temperatures well in excess of licensing basis reactor accident temperatures. It is virtually impossible for a core melt accident. The robust coatings on each fuel kernel provide containment for the radioactive materials. The distributed containment structures incorporated in the HTGR fuel replace the central, massive reinforced concrete structure on nuclear plants currently in service.

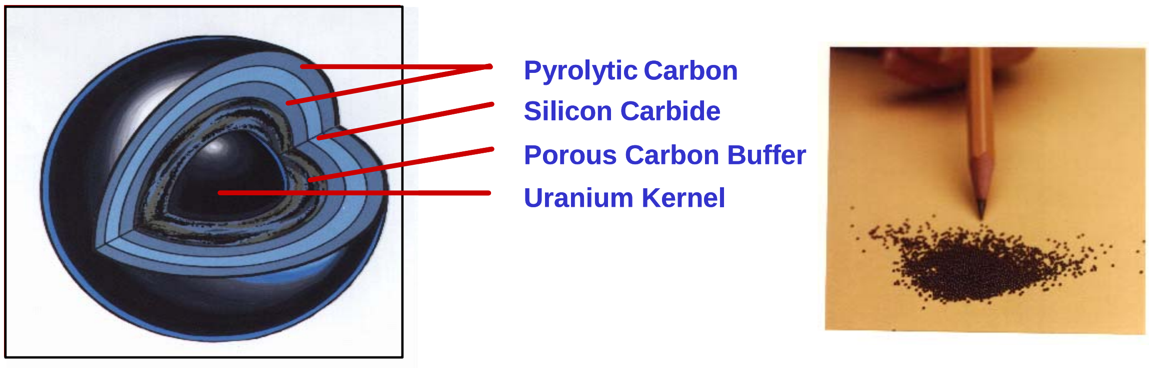

Figure 2-3
HTGR TRISO Fuel Particles showing Uranium Kernel (UO2 or UCO), and the Various Layers Encapsulating the Uranium (left). The Relative Size of the Fuel Particles is Shown on the Right

In the prismatic core design, the particles are bonded together in fuel compacts which are contained in sealed vertical holes in the graphite fuel blocks. These fuel blocks are stacked in columns to make up an annular-shaped core. Refueling of the prismatic reactor is off-line and one-half of the core is replaced. In contrast, the pebble bed design has about 15,000 particles, compacted into 50mm diameter spheres and coated with a 5mm layer of pure carbon. The 450,000 pebbles "flow" through an annulus between central and peripheral graphite reflectors. The pebble-bed reactor is refueled continuously.

There are several developers of HTGR design concepts and technologies, see Figure 2-2 including Pebble Bed Modular Reactor (Proprietary) Limited (PBMR) out of South Africa uses the pebble fuel design, and General Atomics (U.S.), and AREVA (France), use the prismatic fuel design. Additional developers include those associated with the HTTR (prismatic) in Japan and the HTR reactor (pebble) in China.

3

APPLICATIONS OF THE NEXT GENERATION NUCLEAR PLANT TECHNOLOGY

The NGNP Project is the forerunner of what is anticipated to be a large fleet of HTGRs that meet the stringent demands of an evolving world, in terms of energy needs and environmental requirements. With its high temperature process heat, the HTGR is well suited to support increased energy security and reduced greenhouse gas emissions for modern economies, like the U.S. While earlier versions of HTGR plants have been proven as an electricity generator, there are additional applications of the HTGR as an industrial process heat source that can materially change the energy landscape. These applications include electricity and process heat or steam co-generation, hydrogen production, support of upstream production and refining of petroleum, petrochemical and chemical production, and the exploitation of unconventional hydrocarbon sources. Waste heat is still of sufficient quality to provide significant water desalination or district heating as valuable by-products of the primary processes.

The benefits from this advanced nuclear system include:

- Diversification of energy supply to reduce exposure to increasing price and volatility of natural gas and petroleum supplies,
- Improved economics and competitiveness for refined petroleum products and synthetic fuels,
- Improved availability and price stability of process heat and hydrogen,
- Substantially reduced impact on the environment and global climate – reduction of carbon emissions, and
- Leveraged use of indigenous hydrocarbon resources including oil, natural gas and coal.

The potential end-users include electric power producers, the petroleum industry, the chemical industry, industrial gas producers, the transportation industry, coal gasification and liquefaction applications, ammonia and fertilizer producers.

4

BENEFITS OF THE NGNP AND DEPLOYMENT OF THE HTGR TECHNOLOGY FOR EPRI MEMBERS

Why the Utilities Should Be Interested in the HTGR – the Potential Benefits

Electric utilities should be interested in the NGNP as the demonstration plant for HTGR in the US for several reasons. The first reason is that the HTGR provides an alternative, emission-free generation option to complement the on-going advanced light water reactor (ALWR) projects. The second is that the HTGR provides an opportunity for existing nuclear plant owner operators to operate nuclear energy facilities for other industries. Finally, the HTGR provides utilities opportunities to expand their range of energy supplies beyond electricity. Each of these potential benefits are discussed further.

Alternative Emission Free Generation Option

With an increasing need for baseload electricity, coupled with greater emphasis on reducing CO_2 emissions, utilities are faced with a future where more options are needed than what are readily available today. Clearly increased availability of competitive renewables and clean coal technologies is needed. The nuclear energy option is very attractive from reliability and environmental perspectives. The only option presently available to utilities is the suite of large, greater than 1,200 MW(e) ALWRs. This nuclear option may be attractive to those utilities that need a large addition of baseload capacity and are large enough to finance such capital intensive projects. These can be inhibitors for smaller utilities or ones that do not require such a large baseload generation addition in a single plant. Currently, this niche is filled by natural gas fired combined cycle combustion power plants.

Thus, the HTGR and other smaller reactors offer a potential option to utilities. One of the major demonstrations of the HTGR technology is in South Africa in the form of a 165 Mw(e) pebble bed reactor electric generating station using a direct Brayton cycle. The current schedule is for this HTGR to begin plant commissioning in 2017. The South Africans are pursuing this nuclear option because the size fits the growth requirements of ESKOM, the local utility, and the lack of a strong heavy voltage transmission system throughout the country.

Nuclear Operators for Additional Nuclear Energy Systems

A second benefit of the NGNP and subsequent HTGRs is the opportunity for existing nuclear owning/operating utilities to operate nuclear process heat plants for manufacturing and unconventional hydrocarbon production. Discussions with end-users of the nuclear process heat indicate that the companies themselves do not want to be nuclear plant operators and hold NRC licenses. Preliminary estimates of the potential market for nuclear produced process heat are on the order of several hundred 500MW(t) modules. If deployed in these quantities, there will be a large demand for experienced nuclear operational support.

Expanded Energy Supplies for Other Industries

The third benefit is the potential for electric utilities to expand their commercial offering of energy products beyond electricity. There is a growing need for hydrogen, emission-free process heat and steam for industries and process heat and steam for the production of unconventional hydrocarbons.

Hydrogen is required in ever-growing quantities to process the lower quality, higher sulfur crude oil that is available today. The current method for producing hydrogen is through steam methane reformation of natural gas. The increasing price volatility of natural gas and the strong potential for carbon constraints are reasons for developing alternative means for producing hydrogen. Nuclear energy can produce emission-free hydrogen in a number of ways, including:

- conventional water electrolysis (using nuclear generated electricity),
- high-temperature electrolysis (using nuclear generated electricity and steam) requires temperatures up to 900º C for 50% conversion efficiency,
- thermo-chemical cycles water splitting (using nuclear heat) requires temperatures of 850º C,
- hybrid cycles (combining thermo-chemical and electrolytic steps) also requires temperatures of 850º C, and
- steam methane reforming (using nuclear energy for the endothermic heat of reaction and steam), requires temperatures of 800º C.

Industrial process heat is generally produced by the combustion of either natural or process gas. Major users of natural gas include oil refineries, chemical and petrochemical plants, ammonia and fertilizer plants. Natural gas is also the primary feedstock for chemical, petrochemical and ammonia plants. There are three drivers for these industries to consider nuclear energy in their future operations. These drivers are (1) the increasing price volatility and scarcity of natural gas, (2) the potential for carbon constraints, and (3) the need for increased resource utilization in their operation. In the latter case, when less natural gas is used for process heat, more is available for feedstock.

The U.S. has a tremendous amount of unconventional hydrocarbon resources. If energy security is to be achieved, these unconventional hydrocarbon resources must be developed, along with major energy efficiency improvements. Unconventional hydrocarbons include coal, heavy oil, biomass, tar sands (Canada) and oil shale.

The existing processes for utilizing these resources rely on the burning of fossil fuels that produce large amount of CO_2. The integration of advanced nuclear energy resources can reduce the dependence on fossil fuels, generally natural gas, and diminish the production of CO_2.

For example, in the convention coal-to-liquids (CTL) process, about one-half of the carbon in the coal is converted into CO_2. The South African CTL plants are the largest point sources of CO_2 in the world. HTGRs producing hydrogen and oxygen can be integrated into the CTL process with significant improvements in resource utilization and emissions. Such a combination would reduce the coal requirements by over 40% and would eliminate over 95% of the CO_2 emissions. The hydrogen requirements are very large and require multiple HTGR hydrogen production units for each CTL facility.

Another example of HTGR application to unconventional hydrocarbon development is in the production of bitumen from the large tar sands deposits in Canada. Most of the tar sands are too deep for surface mining and require in-situ heating by 350º C steam to reduce the viscosity to a point where it can be pumped to the surface. Currently, the steam is supplied from natural gas fired boilers. If all of the tar sands were exploited, the amount of natural gas required to produce the steam would exceed three times the proven reserves of Canadian natural gas. HTGRs provide an opportunity to produce electricity and a large amount of steam without CO_2 emissions, thus conserving natural gas for more productive uses.

All of these applications of nuclear energy provide an opportunity for nuclear utilities to own and operate nuclear energy plants that co-generate electricity, process heat and hydrogen for key US industries. Some of the key industries have no intention of building or operating nuclear plants. They view their electricity, process heat and hydrogen suppliers as high value added partners. Preliminary studies show that HTGRs are competitive in the co-generation business when natural gas costs approximately $8.00/MMBTU. This breakeven price drops when carbon constraints are considered.

5 STATUS OF THE NGNP

The EPACT05 authorized NGNP Project is a multi-phase effort as summarized in the following table

Phase 1 (Present → 2010)	Phase 2 (2010 → 2017)	Phase 3 (2015 → 2021)	Phase 4 (2021 → 2024)
Program Development & Project Definition	**Plant Design & Licensing**	**Plant Construction & Operation**	**Commercial Demonstration**
• Conceptual Design & Engineering • Licensing Strategy Development √ • Reference Cost & Schedule Baseline	• Select & Complete Detailed Design • Submit Design Certification and/or Combined License Applications for NGNP • Obtain NRC License	• Demo/FOAK Plant Construction • Operator Training • Startup Testing • Initial Operations • Confirmatory Testing	• Operations & Demonstration Runs • Commercial Certification • HTGR Deployments

Figure 5-1
The NGNP Project Phases

The configuration and functional capabilities of the NGNP Project will be selected based on a balance between desired functional requirements, performance, and technology development risks. It is anticipated that the reference configuration will be based on providing process heat at conditions that fulfill the needs of prospective end-users in the production of hydrogen, for direct use in processes such as the production of synthetic fuels and in chemical processing. The pre-conceptual design work was completed in FY2008 for the Idaho National Laboratory (INL). This work defines the configuration and the functional capabilities of this demonstration. The target operation date for the NGNP Project is in FY2021. In parallel, vendor-led specific commercial projects can proceed to assure the timely deployment and to capitalize on the NGNP Project.

The primary purpose of this public/private collaboration is to provide demonstrated private support to this project, and spread the cost, the risk and the benefits broadly, so no one company has a significant exposure. The success of the partnership(s) and the continued funding of the project by the U.S. Government are dependent upon the commitment of the NGNP commercial coalition(s) to support this multi-year effort. The NGNP Project is designed as a collaborative effort between the federal government and private industry; however, industry leadership is the vital ingredient. Central to the success of the project is the establishment of commercial coalition(s) among many industries, including oil and gas, chemical, coal, fertilizer, and other energy companies, the nuclear generation companies and technology development and commercializing companies. It is also necessary to have broad industrial collaboration(s) in order to advance the government's interest (and funding) in this multi-year effort. The cost share formulation will be determined during formation of the coalition(s) and the public/private partnership. It is expected to be primarily determined by the extent of technology development and the risk mutually perceived by the Government and the commercial coalition(s).

The near-term risks of the project are primarily securing sufficient and stable funding from the U.S. Government. To secure federal funds, it is essential that the project attract the necessary private sector support and participation from end-users and other interested parties and obtain value-added, in-kind contributions from technology developers for the respective NGNP Project phases. If sufficient public and private funds are committed, the demonstration plant can be constructed and operated. This near-term risk is addressed through the development of a sound business case for the commercial deployment of HTGRs, the establishment of a solid project plan and the establishment of an effective management structure to drive the project in terms of technology, quality, cost and schedule. The longer-term risk is associated with the successful operation of the constructed plant. The demonstration plant must be safe, reliable, and produce the quality and quantity of product, whether it is hydrogen, process heat and/or electricity, that demonstrate the HTGR's capability to meet the needs of a wide spectrum of end-users. This risk is best managed with sound technology choices and development, and quality design, licensing and construction, and excellent operation. The detailed design and construction of the plant must be led by an experienced team. Likewise, the operation of the plant must be conducted by an experienced commercial nuclear operator. The selection of the teams to develop the technology, and design, build and operate the demonstration plant will be made with value, timing and risk as the primary selection criteria.

In order to secure the necessary funding, the coalition(s) must:

- Obtain the necessary value-added, in-kind contributions commitments from technology developers and nuclear system suppliers,
- Obtain the necessary private participation and support commitments from potential end-users and other interested parties, and
- Broaden the necessary political support to ensure the NGNP Project is viewed and funded as a priority for Congress and the in-coming Administration

6
THE PATH FORWARD

The provisions of EPAct 2005 establish two distinct phases for the NGNP Project. In Phase I, the Department of Energy (DOE) is directed to select the hydrogen production technology and develop initial reactor design parameters for use in Phase II. Phase I is the research and planning part of the initiative, and it is the phase in which DOE is currently engaged. Phase I, to be completed by 2011, will result in an evaluation of available technology and potential design concepts for the NGNP prototype facility. In Phase II, EPAct 2005 directed DOE to complete the design and construction of a prototype plant at the Idaho National Laboratory (INL) by 2021 based on the selected design concept in Phase I. EPAct 2005 also established expectations for NGNP program execution, including industry participation and cost-share, international collaboration, NRC licensing, and review by the Nuclear Energy Research Advisory Committee, now called the Nuclear Energy Advisory Committee (NEAC).

As noted previously, EPAct 2005 requires that the NGNP Project be established, managed and funded through a public-private partnership. DOE is considering using a cooperative agreement as described in 10 CFR Part 600 or a technology investment agreement as described in 10 CFR Part 603 to enter into cost-sharing agreements(s) with industry. The agreement(s) would be structured in a manner that allows the DOE to evaluate, through the review of required deliverables, the programmatic and technical merit in proceeding to each phase of work.

The DOE issued a request for information (RFI) in April 2008 seeking industry input on the proper scale and scope of the prototype, and industry's best cost estimates for that scale prototype that will maximize the taxpayer return and the probability that the prototype will be commercialized. Overall, EPAct 2005 requires a 50/50 cost share between government and industry. Comments were requested on how to structure and sequence the cost-share agreements to provide value to both the public and the private partners. The responses from the RFI were submitted in June 2008.

Based upon the information provided in the RFI, the DOE intends to issue a funding opportunity announcement (FOA) before the end of CY2008. The DOE expects any agreement(s) to cover and address:

- All activities related to the NGNP Project including coordination with DOE on research and development in Phase I,
- The design, licensing, construction, and operation activities in Phase II,
- The technology rights and private ownership of the NGNP capital assets, and
- The appropriate level and phasing of cost-sharing as the project moves through its scope from research/development into design, licensing and construction.

The Electric Power Research Institute (EPRI)

The Electric Power Research Institute (EPRI), with major locations in Palo Alto, California; Charlotte, North Carolina; and Knoxville, Tennessee, was established in 1973 as an independent, nonprofit center for public interest energy and environmental research. EPRI brings together members, participants, the Institute's scientists and engineers, and other leading experts to work collaboratively on solutions to the challenges of electric power. These solutions span nearly every area of electricity generation, delivery, and use, including health, safety, and environment. EPRI's members represent over 90% of the electricity generated in the United States. International participation represents nearly 15% of EPRI's total research, development, and demonstration program.

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